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Soil Report

Sunny South

Tahoe National Forest, Placer County, CA

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Soil Report

Introduction

Analysis of the effects of individual management activities on the soil resource (soil productivity and soil ecosystem functionality) is guided by the Tahoe National Forest Land and Resource Management Plan Standards and Guidelines and Forest Service Manual 2500, Chapter 2550, Supplement 2500-2012-1. The soil stores water, nutrients, and provides favorable habitat for soil organisms which cycle nutrients. Chemical, physical, and biological soil processes sustain plant growth which provides forage, fiber, wildlife habitat, and protective cover for watershed protection (USDA 2012a).

For this soil analysis, Forest Service staff have developed soil quality functions and indicators that are appropriate for the proposed activities, site conditions, and soil characteristics of the project area. Soil quality functions analyzed include: support for plant growth function (soil productivity) and soil hydrologic function. Four indicators were chosen that address relevant issues in the Sunny South project and measure compliance with Forest Plan Standard and Guidelines. The indicators include: soil cover, surface organic matter, soil organic matter, and soil porosity.

For a detailed description of the alternatives considered for analysis and project design features, see Chapter 2 of the Sunny South Project.

Regulatory Framework

The regulatory framework providing direction for protecting soils and a site's inherent capacity to grow vegetation comes from the following principle sources:

- Organic Administration Act of 1897
- Bankhead-Jones Act of 1937
- National Forest Management Act of 1976 (NFMA)
- FSM 2500 –Chapter 2550 –Soil Management
- Tahoe National Forests Land Management Plan (amended by Sierra Nevada Forest Plan, 2004)

The Organic Administration Act of 1897 (16 U.S.C. 473-475) authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

The Bankhead-Jones Act of 1937 authorizes and directs a program of land conservation and land utilization, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion, preserving natural resources, mitigating floods, conserving surface and subsurface moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare.

The Multiple Use-Sustained Yield Act of 1960 directs the Forest Service to achieve and maintain outputs of various renewable resources in perpetuity without permanent impairment of the land's productivity.

The National Forest Management Act of 1976 (NFMA) charges the Secretary of Agriculture with ensuring research and continuous monitoring of each management system to safeguard the land's productivity. To comply with NFMA, the Chief of the Forest Service has charged each Forest Service Region with developing soil quality standards for detecting soil disturbance and indicating a loss in long-term productive potential. These standards are built into forest plans. NFMA specifically states:

Timber Harvest on National Forest Lands (16 USC 1604(g)(3)(E)): A Responsible Official may authorize site-specific projects and activities to harvest timber on National Forest System lands only where:

a. Soil, slope, or other watershed conditions will not be irreversibly damaged (16 USC 1604(g)(3)(E)(i)).

The Forest Service Manual for soil management (FSM 2500, chapter 2550) establishes the framework for sustaining soil quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.

2.2.1 Tahoe National Forest Land and Resource Management Plan Standard and Guidelines

52. Soil Resource Improvement Assessment

Under standard and guideline 52, opportunities are evaluated to improve soil productivity on areas identified in the Soil Resource Inventory (SRI) as being in "altered" condition.

53. Soil Restoration

Under standard and guideline 53, identify areas of soil damage and abandoned roads in need of rehabilitation. Include these areas in project plans for restoration and improvement.

55. Maintain Soil Productivity

The Tahoe National Forest LRMP established the Forest SQS per the National Soil Management Handbook direction and the R5 Soil Management Handbook direction. The Forest SQS are described within the LRMP as S&G #55 presented below. The Regional Forester's letter (February 5, 2007), specific to soil management, reaffirmed that the standards and guidelines in Forest Land and Resource Management Plans provide the relevant substantive standards to comply with NFMA.

The Tahoe National Forest Land and Resource Management Plan (LRMP 1990), as amended by the Sierra Nevada Forest Plan Amendment (SNFPA 2004), provides direction for maintaining long-term soil productivity through standards and guidelines for three soil characteristics: soil porosity, soil cover, and soil organic matter (LRMP, pages V-36 through V-38). When the standards and guidelines for these three soil characteristics (described below) are met on at least 85 percent of an activity area, the soil is considered to be in an acceptable condition, without significant impairment to soil productivity. An activity area is the area where soil-impacting activity has occurred, or is planned to occur, and includes landings, skid roads and trails, and

temporary roads, but does not include system roads. The LRMP notes that it may be difficult to achieve this standard and guideline during fire salvage; rehabilitation, or recovery activities including reforestation of brush fields. It may also be difficult to achieve in areas where existing plant communities have developed inadequate cover or duff, or where resource objectives are in direct conflict. In these situations, a soil scientist will work with the project interdisciplinary team to develop site-specific management prescriptions that approximate this standard and guideline, and do not result in a significant reduction in soil productivity (LRMP, page V-36).

Standard for Soil Porosity (LRMP, pg. V-36)

Maintain at least 90 percent of the total soil porosity found under natural conditions, as measured at 4 to 8 inches below the soil surface over at least 85 percent of the activity area.

Standard for Soil Cover (LRMP, pp. V-36 – V-37)

The soil is considered to be in acceptable condition after a land-disturbing activity when the effective soil cover on an activity area is (1) the minimum amount shown in the following table, or (2) the minimum amount prescribed for a specific site by a qualified earth science specialist after an on-site investigation. The minimum effective soil cover prescribed for a specific site will vary from the values shown in the table due to local differences in slope, micro relief, surface rock fragments, detachability, and other factors that vary within soil types.

Table 1. Minimum Percent Effective Soil Cover (ESC) By Slope Group and Soil Group

		Slope (percent)	
	< 35 percent	**35 – 50 percent**	**> 50 percent**
Soil Group A	70 percent ESC	80 percent ESC	90 percent ESC
Soil Group B	50 percent ESC	60 percent ESC	75 percent ESC
Soil Group C	40 percent ESC	50 percent ESC	65 percent ESC
Soil Group D	30 percent ESC	40 percent ESC	55 percent ESC

Soil Group A: These soils are highly erodible, have developed from granitic parent material, have a short timber rotation length, and are at lower elevations on the Westside of the Forest. None of these soils are within proposed Sunny South treatment units.

Soil Group B: These soils have developed from a variety of parent materials. Their erodibility, geographic location, and climate varies, and they have short to moderate timber rotation lengths. Included are the Aiken, Jocal, Jocal Variant, Mariposa and McCarthy series.

Soil Group C: These soils have developed from a variety of parent materials. Their erodibility, geographic location, and climate varies, and they have moderate to long timber rotation lengths. Included are the Crozier, Hurlbut, Smokey, and Tallac series.

Soil Group D: These soils occur primarily in the true fir zone, have low erodibility and have long timber rotations. Included is the Waca series.

Guidelines for Soil Organic Matter (LRMP, pp. V-37 – V-38)

(1) Maintain Large Woody Material

The objective of this guideline is to maintain soil productivity and nutrient cycling by maintaining woody residues in timber harvest units while allowing the merchantable logs to be removed.

Within the LRMP, Large down woody debris retention is recommended at a rate of 5 of the largest downed logs/acre. Preference is for large cull logs 20 inches or more in diameter and more than 40 cubic feet in volume. Where possible, logs should be evenly distributed throughout the activity area and in contact with the soil. Logs should be in a range of decomposition classes (defined in USDA Handbook 553, page 80), except that at least two logs per acre should be in class 1 or 2. A total volume of 200 to 800 cubic feet of smaller logs, merchantable wood, or other woody material may be substituted when sufficient large logs are not available. Hardwood residues, which have a much shorter residence time, should be considered for retention when conifer residues are absent or in short supply. Large woody material is considered part of effective soil cover under the Standard for Soil Cover.

The activity area for large woody material guideline does not include roadsides and ridges designated for fuel reduction in Practice P1 (Areas emphasizing fire prevention in developed areas, areas of concentrated recreation use and during periods of significant activities).

(2) Maintain Forest Duff

Forest duff helps maintain long-term soil productivity by; (1) providing a source of organic matter and nutrients, (2) providing habitat for soil micro-organisms, and (3) providing mulch that conserves soil moisture.

The goal is to maintain a minimum of 20 percent of the undisturbed forest duff evenly distributed throughout the activity area. Undisturbed duff is duff that has not been displaced or moved, its natural porosity is intact, including a well-decomposed layer at the interface with mineral soil, the thickness of its well-decomposed layer has not been reduced, and its surface may be charred by fire, but not consumed.

Undisturbed forest duff has the capacity to absorb soil being displaced and transported by sheet erosion. Undisturbed forest duff is also a source of organic matter, nutrients, and microbial habitat.

Forest duff is considered part of effective soil cover under the Standard for Soil Cover. Because of its special qualities, forest duff may be used to reduce the requirements of the soil cover standard as follows:

Where more than 20 percent of undisturbed forest duff is maintained, the effective soil cover required under the soil cover standard may be reduced by 5 percent for each 10 percent of undisturbed duff over 20 percent. This applies only to Soil Groups B, C, and D in the Standard for Soil Cover. The proposed action has been reviewed and is determined to be in compliance with the management framework applicable to this resource.

Management Requirements

Environmental effects are assessed with the intent and assumption that the management requirements included in the MMR Table of the Sunny South CE are effectively applied to the

action alternatives. Management requirements are prescriptive measures that aim to prevent adverse effects upon the soil resource and include measures to ensure the standards for soil resources are attained. Some management requirements incorporate mitigation measures to be conducted in conjunction with operations for treating unavoidable adverse effects.

Watershed, Soils, & Aquatic Resources – Slope limitations for ground-based equipment.	Limit the slopes on which tractor prescription activity takes place. To control erosion and soil disturbance, limit down hill tractor activity to less than 35% slopes and uphill to less than 25% unless the leading end is suspended. Tractor piling should be limited to 30% slopes and below. (BMP 1-9)	Planning and Prep Forester, Hydrologist, Soil Scientist, District Fuels Specialist.
Watershed, Soils, & Wildlife – Coarse Woody Debris	Unless large down woody debris exceeds 10 tons/acres, retain down large woody at a rate of 5 of the largest downed logs/acre. Preference is for large cull logs 20 inches or more in diameter and more than 40 cubic feet in volume. Units slated for underburning will avoid ignition of large woody debris. Mastication will avoid existing large woody debris and leave additional coarse wood on the ground (i.e. not grind it into the ground.)	Sale Administrator, Soil Scientist, Hydrologist, District Fuels Specialist, Wildlife Biologist.
Watershed, Soils, & Wildlife – Pile Burning	If burn piles contain greater than 25 percent material greater than 8 inch diameter, burn when soils are moist or wetter.	Sale Administrator, Soil Scientist, Hydrologist, District Fuels Specialist, Wildlife Biologist.
Watershed, Soils, & Aquatic Resources – Soil moisture	Operate mechanical equipment when soil moisture is less than 20 percent by weight. If watershed specialist is unavailable to sample soil, use ball method to test for operability (Table 1).	Sale administrator, COR, Soil Scientist, Hydrologist, Fuels Specialist.
Watershed, Soils, & Aquatic Resources – Tilling roads, landings and skid trails	Till/sub-soil landings, main skid trails, temporary roads, and unauthorized routes with equipment such as a winged sub-soiler or other tilling device to a maximum depth of 18 inches so that the soil is lifted vertically and fractured laterally to alleviate detrimental compaction (where it occurs) following completion of all management activities. Tillage/sub-soiling will be completed outside of the tree drip line so as not to impact root systems.	Planning Forester, Prep Forester, SA, Soil Scientist, Hydrologist, Silviculturist.
Watershed, Soils, & Aquatic Resources – Soil cover	Before winter precipitation, maintain at least 50 percent effective soil cover on main skid trails, temporary roads, and decommissioned unauthorized routes.	Soil Scientist, Culturist, Silviculturist, SA and Fuels Specialist.
Watershed, Soils, & Aquatic Resources – Soil cover	Operate feller buncher on terraces within unit S-1 if hand falling is not feasible. Access terraces from the south end, and travel between terraces on routes mapped. If feller buncher use results in unacceptable terrace widening, generally greater than 2 feet, rehabilitate terrace by recontouring where feasible. Subsoil terraces used if needed to reduce detrimental compaction to less than 15 percent of unit.	SA, Soil Scientist, Hydrologist

Methodology

The National Forest Soil Disturbance Monitoring Protocol (NFSDMP) was used to collect soil disturbance data. NFSDMP data was gathered using a random transect approach that consists of between 2-5 passes through a unit with between 30-60 data points collected. The NFSDMP categorizes disturbance into four classes. Soil disturbance class 0 is undisturbed or natural condition. Soil disturbance class 1 can include faint ruts or wheel tracks <5 cm deep, slight compaction in the surface 10 cm, light intensity burn, and slight erosion. Soil disturbance class 2 can include ruts or wheel tracks 5-10 cm deep, moderate compaction up to 30 cm deep, moderate intensity burn, and moderate erosion. Soil disturbance class 3 can include ruts or wheel tracks >10cm deep, severe compaction more than 30cm deep, high burn intensity, and severe erosion that has produced rills or gullies. Results from the NFSDMP are discussed in the existing condition section. See the GTR WO-82a for complete explanation of methods used in the NFSDMP (USDA Forest Service, 2009).

Units were first inspected using recent aerial and LIDAR imagery. Observations of aerial imagery indicated that there were low amounts of bare soil, and LIDAR imagery indicated high amounts of previous disturbance from past forest management such as skid trails, windrows and terracing. Much of this disturbance was caused from ground based harvest and site preparation following the Volcano Fire in 1960.

Units were selected for field review based on the amount of linear features, other than system roads and trails, identified from LIDAR imagery. This included temporary roads, windrows, and terraces.

Site and soil data was collected from plots while making traverses across each unit and collecting approximately 30 points per unit. Soil Disturbance Monitoring protocol was used to assess previous impacts such as burning, rutting, compaction, and loss of soil cover. The level of soil disturbance was estimated for each soil disturbance type. Large woody debris and forest floor were also measured. Existing soil survey information (Soil Survey Staff, 1972) was used unless field investigation revealed significant differences between mapped soils and the actual site-specific soils.

Compaction Risk Rating

The compaction risk rating scheme is intended to help determine the general susceptibility to loss of soil productivity from heavy equipment operation (Table 2). It is based upon the soil texture and rock content. It presumes the soil is at field capacity or at a moisture level at which it is most susceptible to soil density increase under heavy equipment operation (USDA, 2006).

A slight rating indicates that the soil is subject to little or no compaction, moderate indicates that compaction is likely between 4 to 12 inches deep, and high indicates that increased compaction would occur greater than 12 inches deep and would result in losses to productivity.

Table 2. Compaction Risk Rating

Coarse Fragment Content by Volume	Soil Texture	Hazard Rating
Fragmental (> 70%)	Any Texture	Low
Skeletal (35 - 70%)	Sandy	Low
Skeletal (35 - 70%)	Loamy	Moderate
Skeletal (35 - 70%)	Clayey	High
< 35%	Sandy	Low
< 35%	Loamy	Moderate
< 35%	Silty	High
< 35%	Clayey	High

Analysis Indicators

Four indicators have been chosen to address relevant issues in the Sunny South Project and measure compliance with Forest Plan Standard and Guidelines. These indicators include: soil porosity, soil cover, large woody material, and forest duff.

The unit measures for each indicator is acres not meeting desired conditions. Soil porosity desired conditions are not met when soil porosity has been reduced by greater than 10 percent 4 to 8 inches below the soil surface. Platy structure, and/or signs of overland flow and erosion indicate a greater than 10 percent reduction in soil porosity.

Soil cover desired conditions are not met when soil cover is less than 50 percent.

Large woody material is coarse wood greater than 20 inches in diameter which is either down, or standing and dead. The large woody material indicator is not met when there is less than 5 logs per acre, and partially met when there are at least 500 cubic feet per acre of material 10 to 20 inches in diameter.

Forest duff desired conditions are met when there is less than 20 percent undisturbed duff.

Spatial and Temporal Bounding of Analysis Area

For all four soil indicators, the analysis area is bounded by the project activity units, where soil-disturbing activities can take place. The analysis is further bounded in time by the foreseeable future period during which effects of this project can persist as detectable, significant effects. Soil cover, as it affects soil cover, can recover quickly if needle-cast is available, and grasses, forbs, and shrubs re-sprout. The temporal boundary for soil cover is five years. Soil organic matter can take a long time to rebuild after it is lost through displacement or erosion. Once compacted, soil structure can remain affected for decades. The temporal boundary for soil organic matter, surface organic matter, and soil porosity is 30 years.

Affected Environment

Soils within the project area are mainly derived from Andesitic mudflow rock, medisedimentary, or ultramafic rock. A soil map can be found in Appendix A and Table 3 displays the proportion of general soil groups and the corresponding soil properties used in the analysis of this report.

The dominant soils within the analysis area are mostly deep loams indicating high productivity, yet high susceptibility to rutting from mechanical equipment. Approximately 25 percent have gravelly texture modifiers, indicating a high potential for infiltration and resistance to

mechanical equipment. Specific dominant soils include the Cohasset, Crozier, Mariposa, Forbes, and Aiken. Compaction ratings are moderate for these soils.

The affected environment includes past actions within the project area. The 1960 Volcano wildfire has impacted soil organic matter and soil cover. The greatest impacts to soil structure have occurred on approximately 77 percent of the project area that have been impacted by vegetation management using heavy equipment within the last 30 years. The management practice of windrowing occurred on 25 percent of soils in which the surface horizon has scrapped into rows or piles. In addition, 10 percent of the soils were terraced where skid trails were constructed on steeper sideslopes approximately every 100 feet. Both these altered and terraced soils have had their A horizons displaced over a large area and do not meet desired conditions for surface organic matter. Table 3 shows soil families and associated properties used in analysis.

Table 3. Soil properties within the Sunny South project area

Family	Soil Properties used in Analysis			
	Percent of Activity Area	Surface Textures	Soil Depth, inches	Compaction Hazard
Cohasset	22%	Loam, Cobbly loam	60	Moderate
Crozier	12%	Loam	40	Moderate
Mariposa	11%	Gravelly loam	30	Moderate
Forbes, altered	9%	Gravelly loam	50	Moderate
Crozier, altered	8%	Loam	40	Moderate
Aiken	7%	Loam	70	Moderate
Dubakella	7%	Loam	30	Moderate

Field monitoring results indicate that the extent of detrimentally compacted soil is high, yet soil cover and soil organic matter are meeting desired conditions. This indicates past forest management has had a major impact on detrimental soil porosity and that soil cover and soil organic matter have mostly recovered from the 1960 Fire.

Soil Porosity

Within the Sunny South project area, soil textures of loam, gravelly loam, and cobbly loam produce moderate compaction ratings (table 2).

A greater than 10 percent reduction in soil porosity was measured on approximately 12 percent of the soil plots monitored and approximately 341 acres of the project area are not meeting desired conditions for soil structure and macro porosity.

Soil Cover

Currently, approximately 90 acres of the project area are not meeting desired conditions for soil cover (see table 5) because they have less than 50 percent soil cover.

Table 4. Area (acres) meeting desired condition, existing conditions

Indicator	**Met**	**Partially met**	**Not met**
1. Soil Porosity	2,396	74	341
2. Soil Cover	2,647	0	90
3. Large Woody Material	0	485	2,252
4. Forest Duff	2,516	0	221

Large Woody Material

On a unit wide basis, none of the project area is meeting desired conditions for Large Woody Material because down woody material greater than 20 inch diameter is lacking. Desired conditions are partially met on 485 acres because sufficient material 10 to 20 inches in diameter exists.

Forest Duff

The current condition is that approximately 221 acres of the project area are not meeting desired conditions for forest duff because it has been displaced, mostly on main skid trails, or due to site preparation treatments of windrowing or terracing.

Displacement is the removal of surface layers of the mineral soil generally by mechanical means. Displacement results in the removal of nutrient surface horizons, exposing the subsurface. This subsurface is deficient in soil nutrients, reduces infiltration, and has higher natural soil strength impeding root penetration.

Environmental Consequences

Alternative 1 – Proposed Action

Direct and Indirect Effects

Summary

The proposed action would improve soil porosity and down large woody material, and result in minor reductions to soil cover and forest duff. Soil cover is expected to increase in the short term due to needle cast. Overall, there would be net benefit to soil productivity under the proposed action which is expected to meet Forest Plan standards and guidelines.

Ground based harvest would result in the greatest impacts to soil quality by compacting soil, removing soil cover, and displacing forest duff. Fuels treatments using lower psi mechanical equipment to pile or yard material would be expected to have similar impacts, yet to a lesser degree. A soil management requirement would require maintaining at least 50 percent effective soil cover on main skid trails, temporary roads, and decommissioned unauthorized routes. If successfully implemented, this MR would result in most areas meeting the soil cover indicator.

It is expected soil structure would meet desired conditions on all units because the proposed action proposes to subsoil or rip compacted soil on approximately 9 miles of non-system roads and trails, landings, main skid trails and temporary roads.

Proposed underburning would have minimal impacts to soil quality. The greatest impacts would occur due to line construction activities where dozers are used to scrape control lines to mineral soil. Underburning could benefit soil quality by lessening the impacts of a potential wildfire on soil organic matter and soil cover.

Table 5. Area (acres) not meeting desired condition

Indicator	Existing condition	Proposed action
1. Soil Porosity	341	162
2. Soil Cover	90	282
3. Large Woody Material	2,252	2,080
4. Forest Duff	221	388

Soil Porosity

The proposed action is likely to result in 162 acres not meeting the soil porosity indicator. This would be an improvement compared to the existing condition. Some existing compacted skid trails, landings, and temporary roads would be reused, then subsoiled. In addition, the proposed action would subsoil areas with legacy compaction on approximately 9 miles of non-system roads and trails, landings, main skid trails and temporary roads.

Reduced infiltration and permeability capacity is expected due to the use of mechanical equipment on landings, skid trails, and new temporary roads. Construction of new landings, and temporary roads would reduce infiltration to near zero.

Where ground based harvest is proposed, soil types are rated with moderate compaction ratings. Changes in porosity occur both by the reduction of soil pore space by force applied to the soil surface (compaction) and the filling of pores by soil and ash material (soil sealing).

Within tractor units, detrimental compaction is expected on skid trails, landings and temporary roads. Williamson and Neilson (2000) found that maximum compaction occurs after 3 passes of log-laden equipment. Landings are areas of high compaction because they support skidding equipment, processors, and log trucks. The management requirement to subsoil all new temporary roads, skid trails and landings would substantially decrease the negative effects of compaction. Powers (2002) observed that subsoiling significantly improved the porosity of soils.

On proposed skyline units, no skid trails will be used. Except for landings, and new temporary roads, detrimental compaction is not expected outside cable corridors.

Table 6. Area (acres) meeting desired condition – proposed action

Indicator	Met	Partially met	Not met
1. Soil Porosity	2,575	0	162
2. Soil Cover	2,455	0	282
3. Large Woody Material	657	0	2,080
4. Forest Duff	2,349	0	388

Soil Cover

Under the proposed action, it's estimated approximately 282 acres of the project area would not meet desired conditions for soil cover (see table 6) because soil cover would be less than 50 percent. EHRs have been calculated as low to moderate following mechanical harvest.

The proposed action is likely to result in less than 50 percent cover and the soil cover indicator would not be met on approximately 10 percent of proposed ground based units, and 2 to 3 percent of proposed skyline units. These estimates are based on post timber harvest monitoring conducted on the westside TNF (McComb, 2012). Construction of new temporary roads, associated with ground based harvest, would have the highest impact to soil cover and sedimentation (Rice et al. 1972). If the management requirement is effectively implemented to maintain at least 50 percent effective soil cover on main skid trails, temporary roads, and decommissioned unauthorized routes, the soil cover indicator would be met on most areas. Also, where canopy cover is sufficient, needle cast could provide additional soil cover

Soil erosion associated with forest roads is particularly severe during the first year or two after construction, before cut banks and fill slopes have revegetated and stabilized (Peterson, 2009). As discussed in the section above on soil porosity, a management requirement would require subsoiling new temporary roads and landings. This would promote the recovery of soil cover. In addition, the Timber Sale Contract clause, B6.63 Temporary Roads, requires the purchaser to employ such measures as outsloping, drainage dips, and water-spreading ditches to limit accelerated erosion.

Proposed underburning would have minimal impacts to soil cover. The greatest impacts would occur due to line construction activities where dozers are used to scrape control lines to mineral soil. Where control lines are inaccessible for equipment, hand-line construction to mineral soil would occur.

By design, underburning is typically low severity, and would burn 60 to 80 percent of a unit. In the southern Sierra Nevada, a median of less than 90 percent soil cover remained on 130 plots following prescribed burning treatments (Berg and Azuma, 2010).

Large Woody Material

It is anticipated approximately 2,080 acres would not meet the desired condition for large woody material. This would be an improvement compared to the existing condition. Large woody material would increase in older stands, such as unit 12 and 27 where larger, non-merchantable material is left on the ground. This is more difficult to achieve in the younger plantations where there is less, large non-merchantable material. The soils management requirement would require large woody material to be left within a unit, unless it exceeds 10 tons per acre. Therefore, the large woody material indicator would be met in units where the material is available.

Underburning could consume some surface organic matter, yet it could result in some tree mortality which would increase surface organic matter. Stephens and Moghaddas (2005) found that use of prescribed fire did not significantly change the volume of down woody material compared to no treatment.

Forest Duff

It is anticipated that forest duff would not meet desired conditions on approximately 13 percent of units proposed for both ground based harvest and less than 1 percent of proposed cable yarding units. This estimate is based on post timber harvest monitoring conducted on the westside TNF (McComb, 2012). Less soil organic matter would decrease soils ability to hold moisture, with implications for soil biota, and plant growth (Brown, 2003).

The most severe displacement of forest duff is expected to occur during temporary road construction and on landings and main skid trails. Temporary road construction would result in

the highest impacts to forest duff, especially on steeper side slopes which would require excavation of a cut slope. Ground based skid trails would result in displacement of forest duff on skidder tracks, and where yarded trees dig into the mineral soil surface and wedge the surface to the side. This creates berms and piles along the edges of skid trails. Displacement caused by new skid trails and temporary road construction will be considered a long-term disturbance as no mitigations to replace displaced forest duff are planned. On proposed harvest units, jackpot pile burning would be expected to produce enough heat to consume forest duff within the footprint of the piles.

Burning smaller piles on wetter soils are unlikely to result in major impacts to forest duff and soil organic matter. The extent and burn severity is unknown and is dependent on the size of the piles and distribution of fuels. The impact will be limited to the pile locations and small areas of high concentrations and therefore is not expected to be significant. By design, proposed underburning would result in low soil burn severity and therefore would have minimal impacts to soil organic matter. Low severity underburning could have beneficial impacts to soil organic matter (Haase and Sackett 1998).

Cumulative Effects

Past effects due to forest management and the 1960 Volcano fire have been considered and discussed in the direct and indirect effects analysis. In summary, wildfire and forest management have impacted soil porosity, soil cover, surface organic matter, and soil organic matter. These impacts have been described in the existing condition and analyzed in the effects analysis. The highest cumulative impacts are mostly likely to occur in unit BF-1 where legacy compaction on skid trails and temporary roads would not be subsoiled unless they are reused during proposed ground based harvest. If detrimental soil compaction exceeds 15 percent within BF-1 or any other unit, tillage would be used to rehabilitate the soil as described in Forest Plan standard and guideline #55.

There are no other reasonably foreseeable future actions that would occur within the same activity area as this project.

Adding the effects of alternative 1 to the effects of past, present, and reasonably foreseeable future actions are unlikely to have negative effects on soil desired conditions. MRs have been developed to maintain soil porosity, soil cover, surface organic matter, and soil organic matter.

Compliance with law, regulation, policy, and the Forest Plan

Under the proposed action, soil indicators would not be met on approximately 393 acres or 13 percent of the project area, mostly for the soil organic matter and soil cover indicators. This would be an increase of approximately 7 percent from the existing condition. Although this is approaching the 15 percent disturbance threshold for detrimental disturbance in the TNF Land Management Plan, soil quality is expected to remain in good condition. The continual addition of needle cast will add soil cover and decrease the area not meeting the soil cover indicator. The proposed action would result in an improvement to soil porosity on approximately 179 acres and an improvement to the large woody debris indicator on approximately 172 acres.

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